GOES-R Aviation Weather Applications

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Aviation Weather Center

Aviation is Weather Sensitive

- Thunderstorms
- Turbulence
- Aircraft Icing
- Volcanic Ash
- Head/Tail Winds
- Clouds/Restricted Visibility

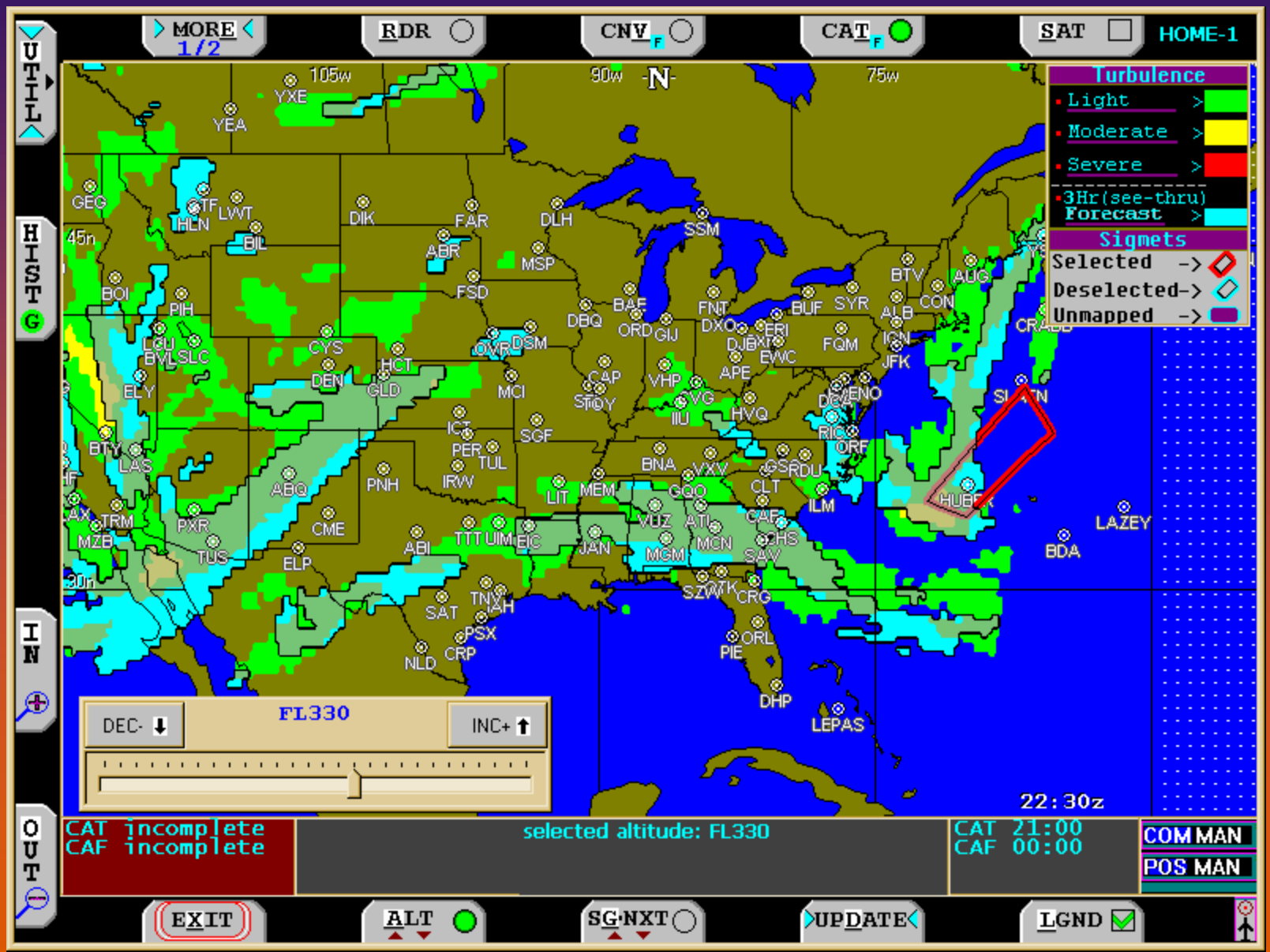
New Technologies for Aviation Weather

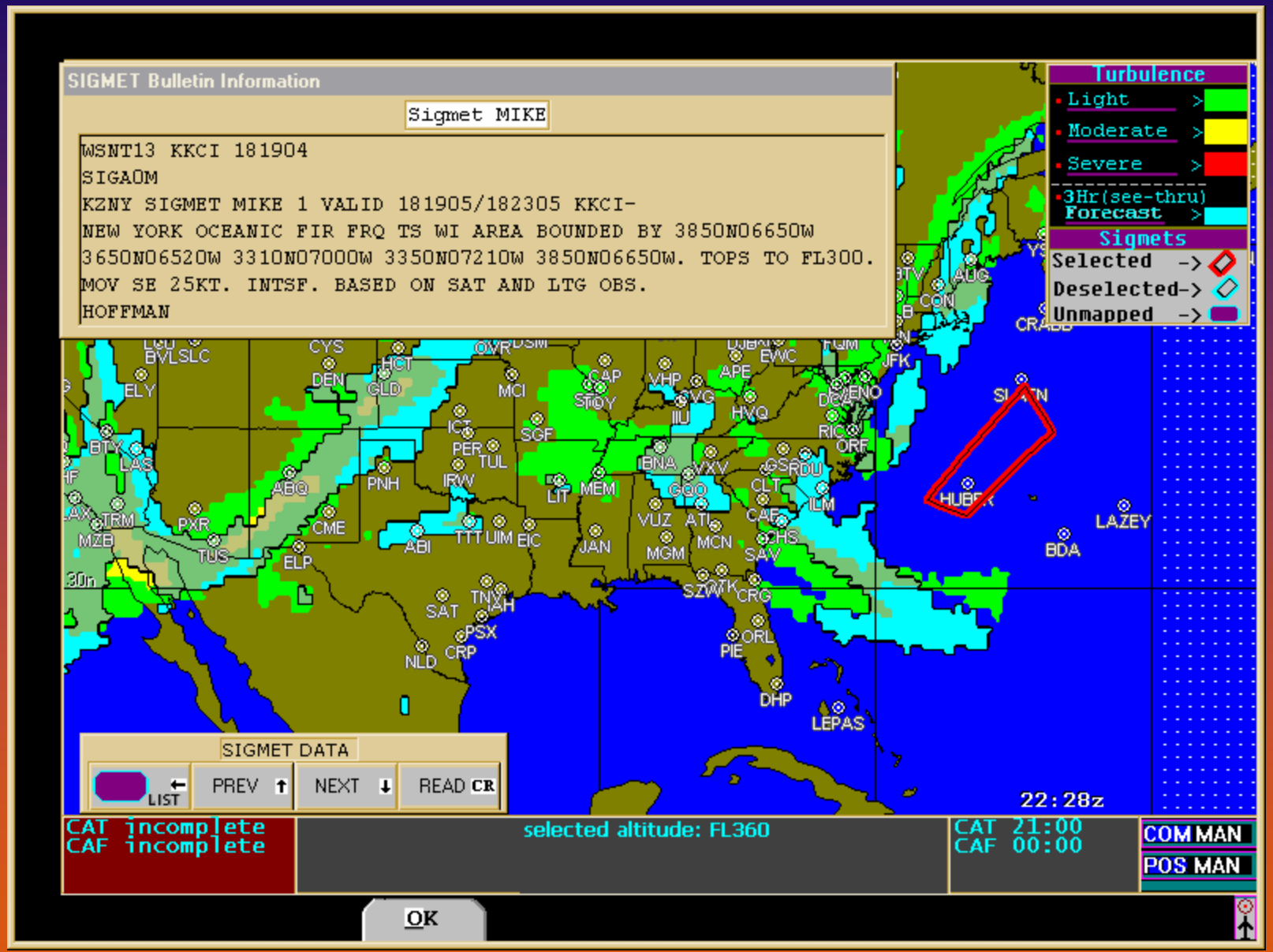
- Weather in the cockpit displays.
- New remote sensing tools.
- Improved weather forecast models and aviation forecast algorithms.

Weather in the Cockpit

- 240x320 resolution video monitor in instrument panel of aircraft.
- 30Kbs communications link to aircraft.
- Commercial services for displays of aviation specific data.
- Available for commercial and general aviation aircraft both within US and globally.

Honeywell Weather Information System -- WINN

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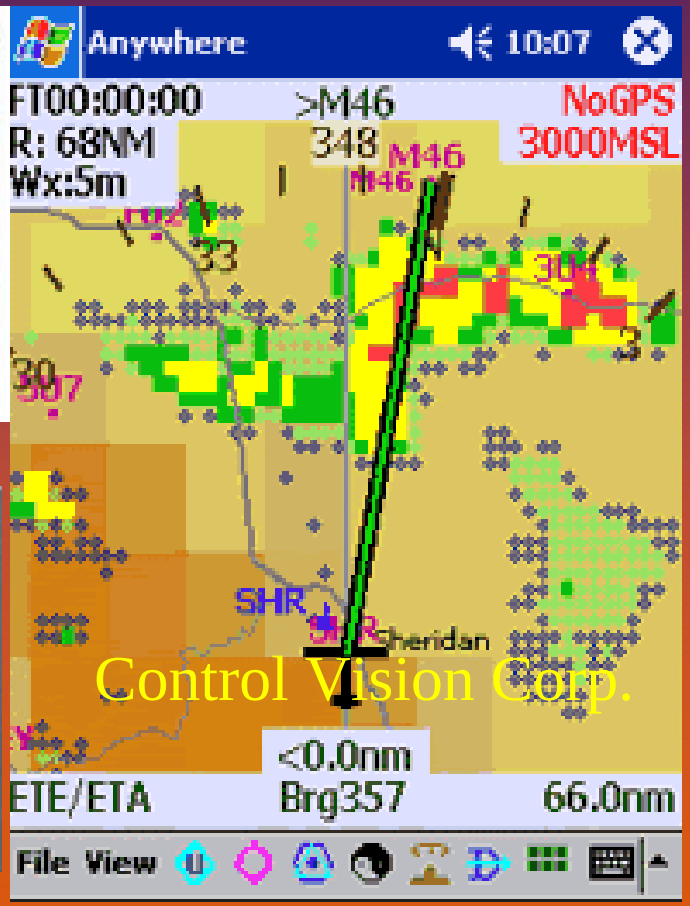
Sigmet MIKE
WSNT13 KKCI 181904
SIGA0M
KZNY SIGMET MIKE 1 VALID 181905/182305 KKCI-
NEW YORK OCEANIC FIR FRQ TS WI AREA BOUNDED BY 3850N06650W
3650N06520W 3310N07000W 3350N07210W 3850N06650W. TOPS TO FL300.
MOV SE 25KT. INTSF. BASED ON SAT AND LTG OBS.
HOFFMAN
Turbulence
Light
Moderate
Severe
3Hr(see-thru) Forecast
Sigmets
Selected ->
Deselected->
Unmapped ->
SIGMET DATA
LIST
PREV
NEXT
READ CR
22:28z
CAT incomplete
CAF incomplete
selected altitude: FL360
CAT 21:00
CAF 00:00
COM MAN
POS MAN
OK

Cockpit Displays

Echo Flight Cheetah FL270



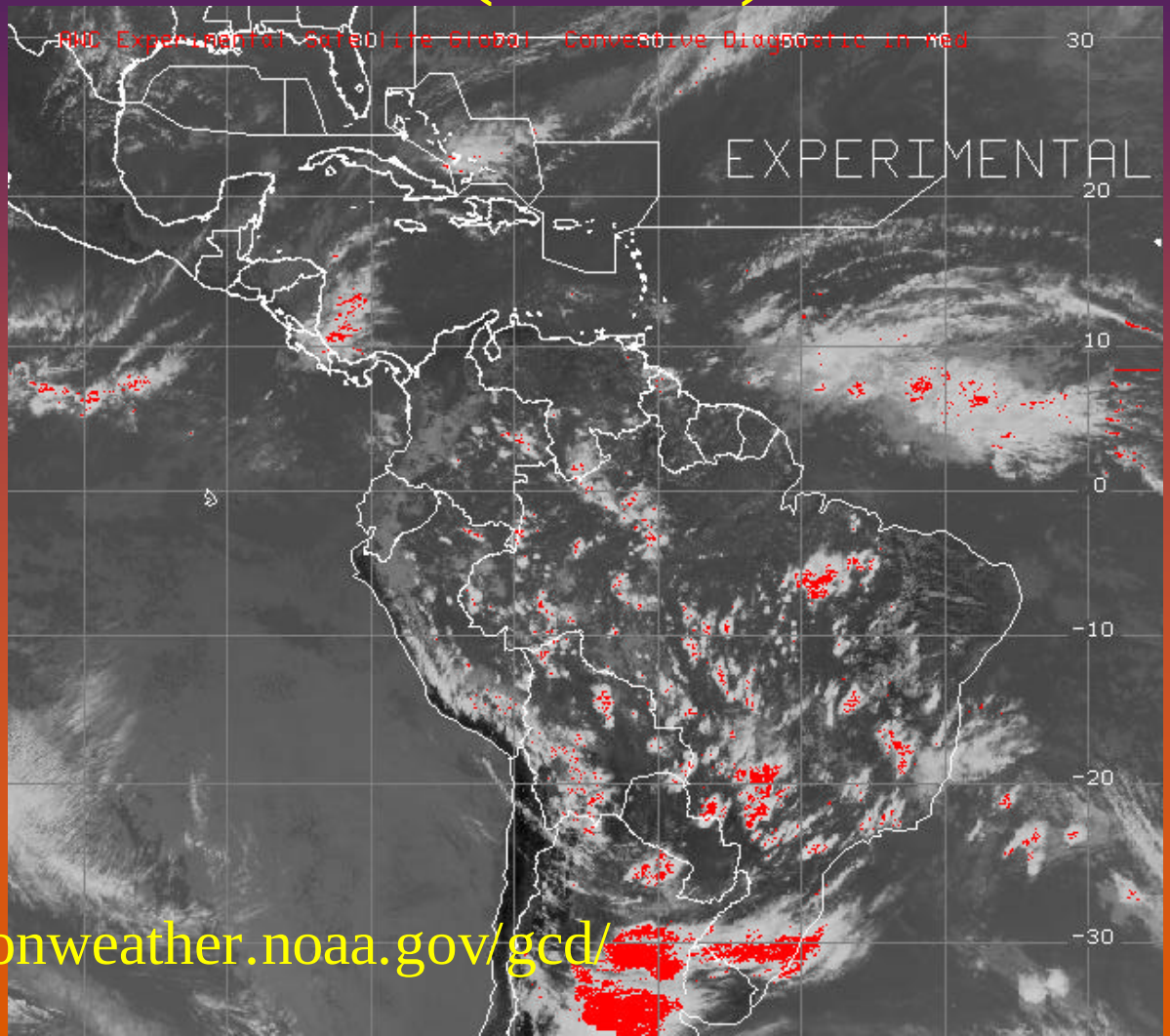
Control Vision Corp.

Avidyne Flightmax 850

New Thunderstorm Detection Tools

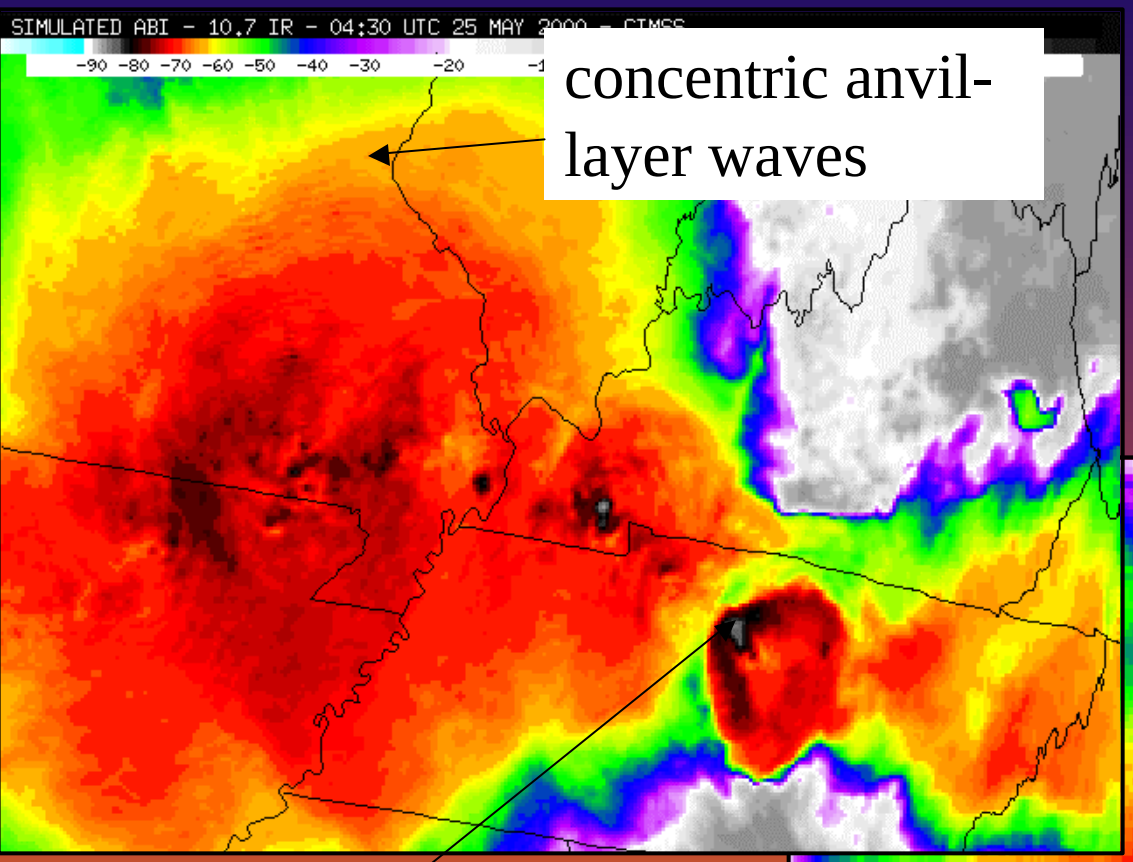
- Multi-channel algorithms such as the Global Convective Diagnostic(GDC) (infrared and water vapor).
- Higher resolution GOES IR channels.
- Lightning Mapper

Global Convective Diagnostic (GCD)



http://aviationweather.noaa.gov/gcd/

Higher Resolution Goes Channels



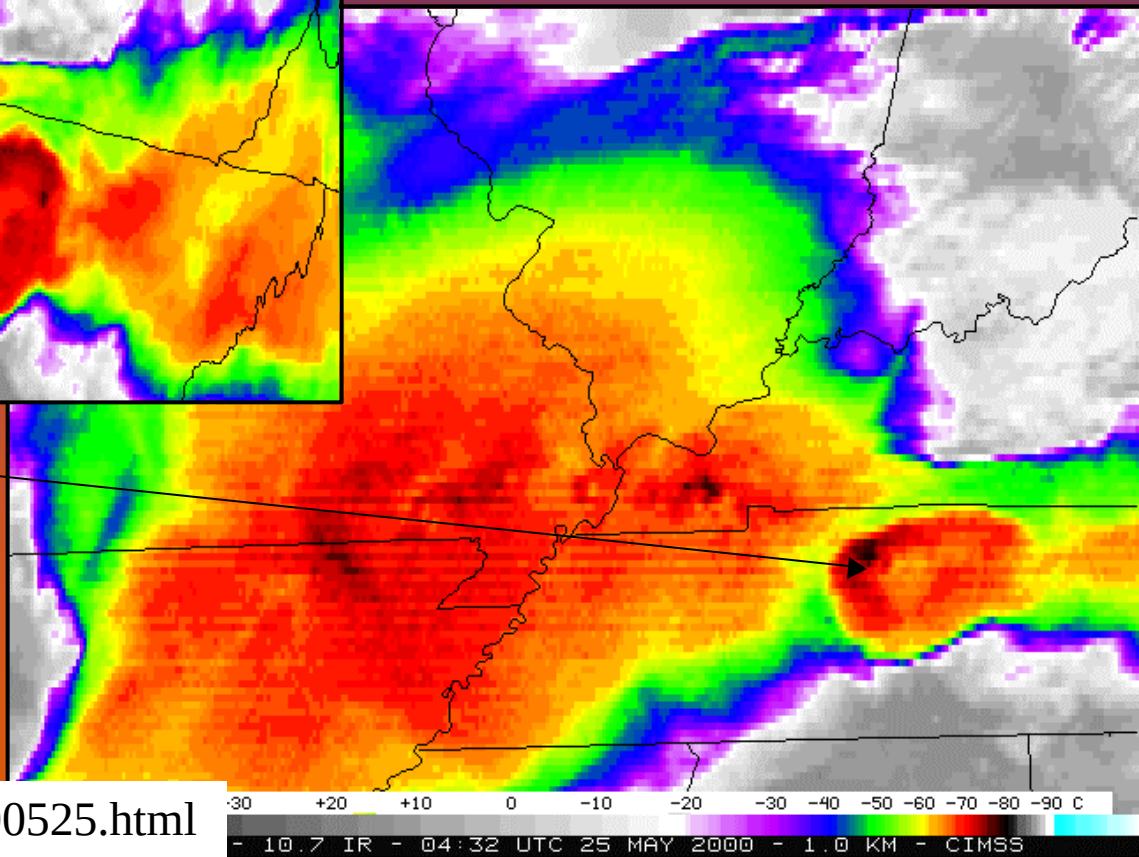
concentric anvil-layer waves

Simulated ABI (from MODIS)

Enhanced "V": IR windows May 25, 2000

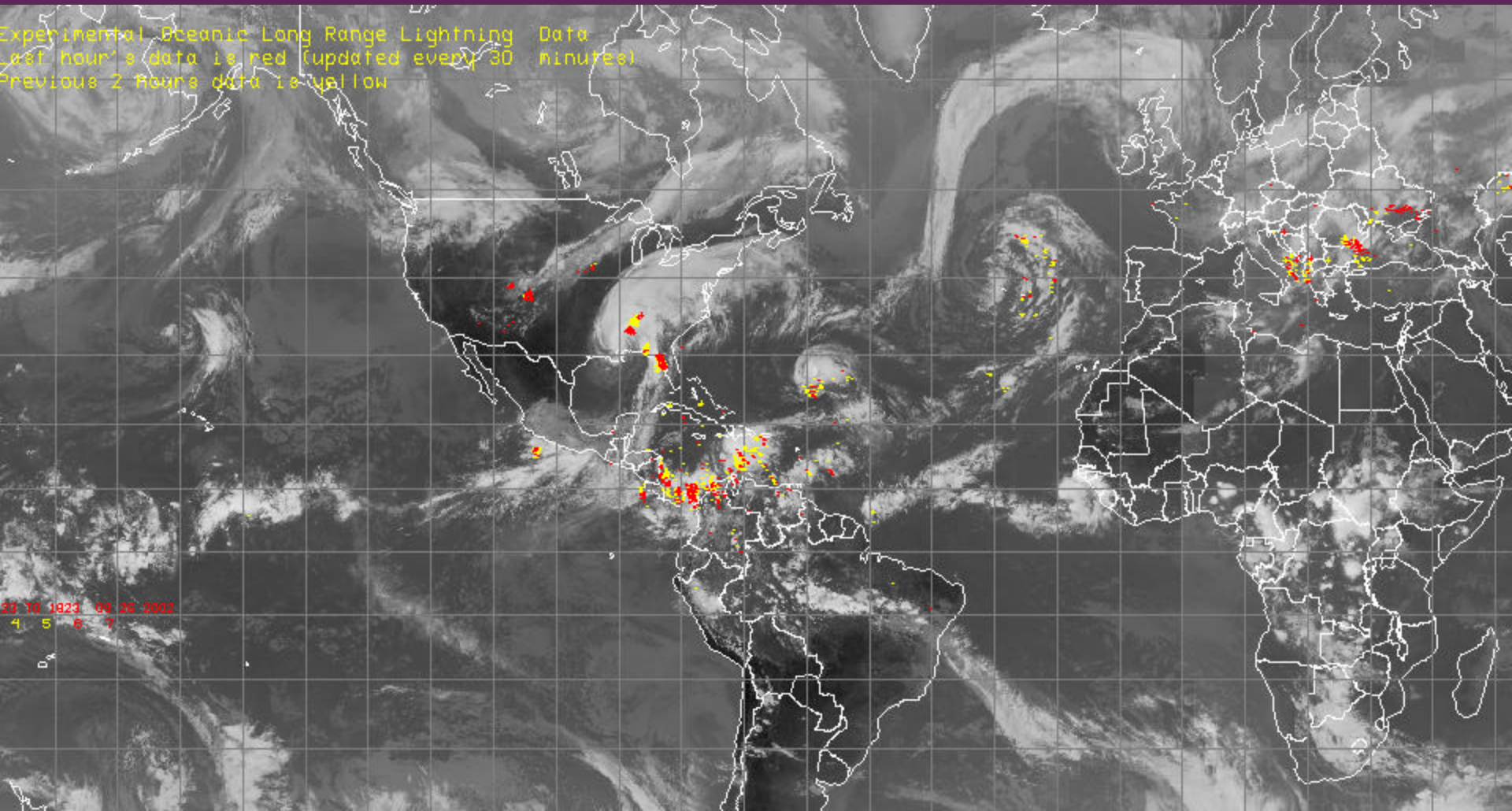
Enhanced "V"

Actual GOES



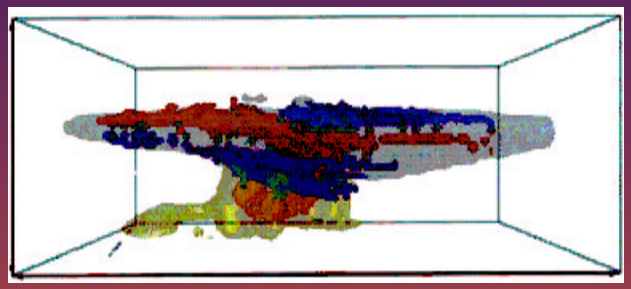
http://cimss.ssec.wisc.edu/goes/misc/000525.html

Current Land Based Lightning Detection

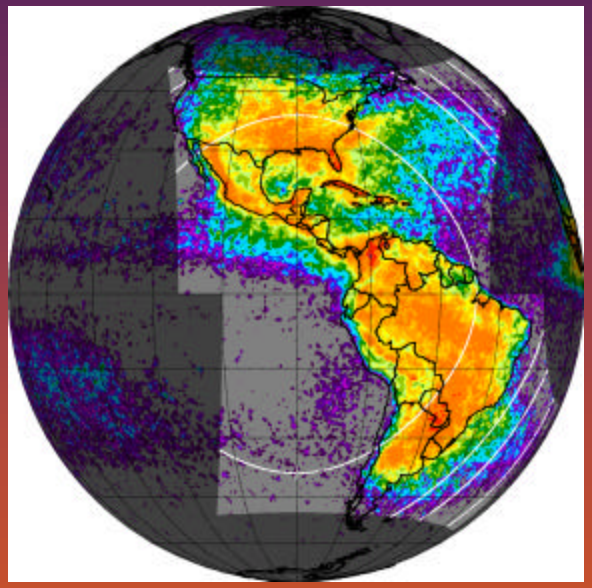


Continuous total lightning from GEO will identify intensifying storms and severe storm potential

Process physics understood

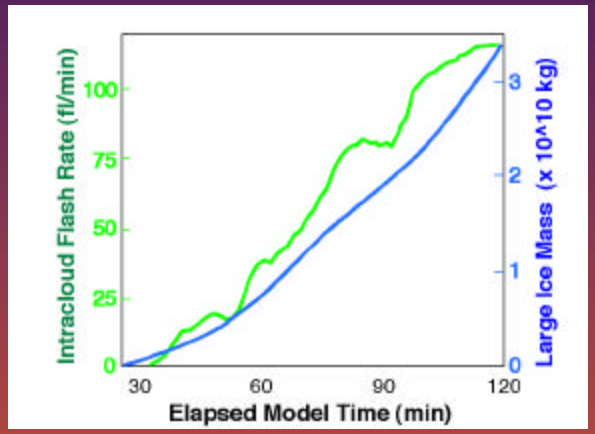


Storm-scale model for decision support system

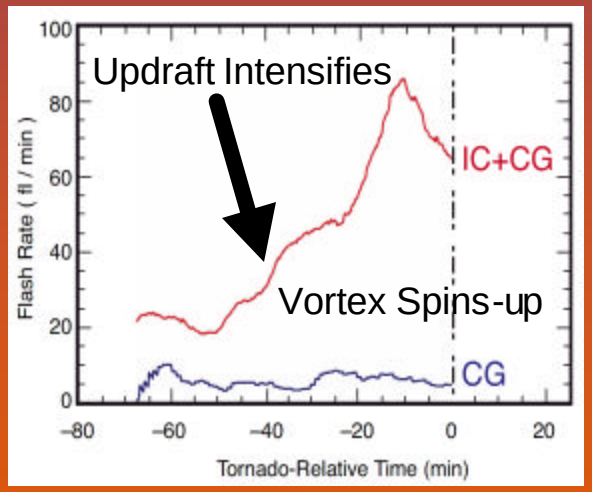


Demonstrated in LEO with OTD & LIS

Ice flux drives lightning



Physical basis for improved forecasts



Lightning jump precedes severe weather

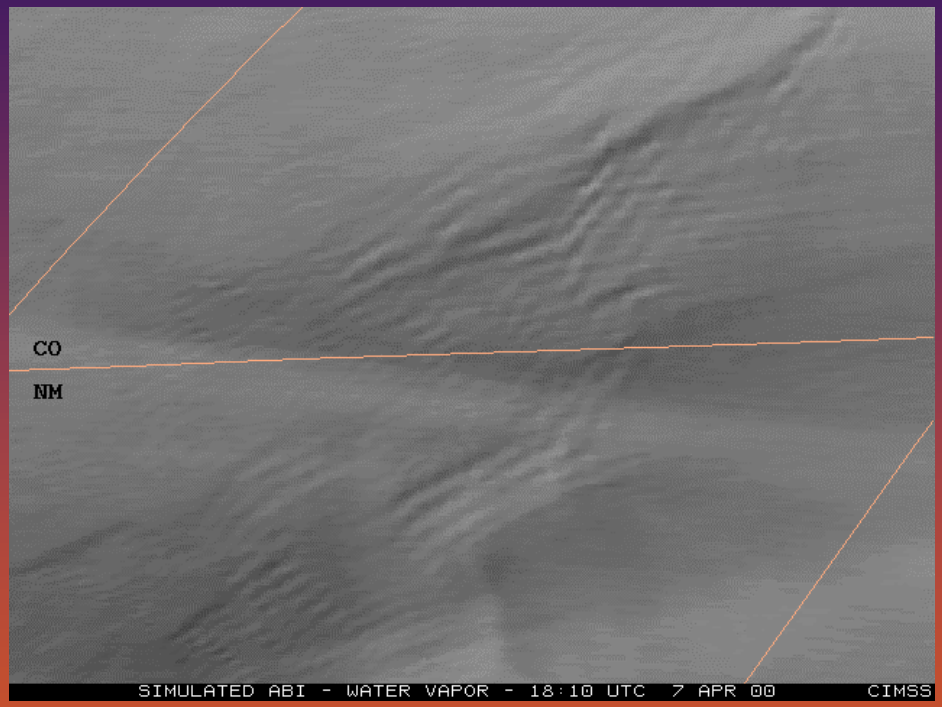
Lightning improves storm predictability

New Turbulence Tools

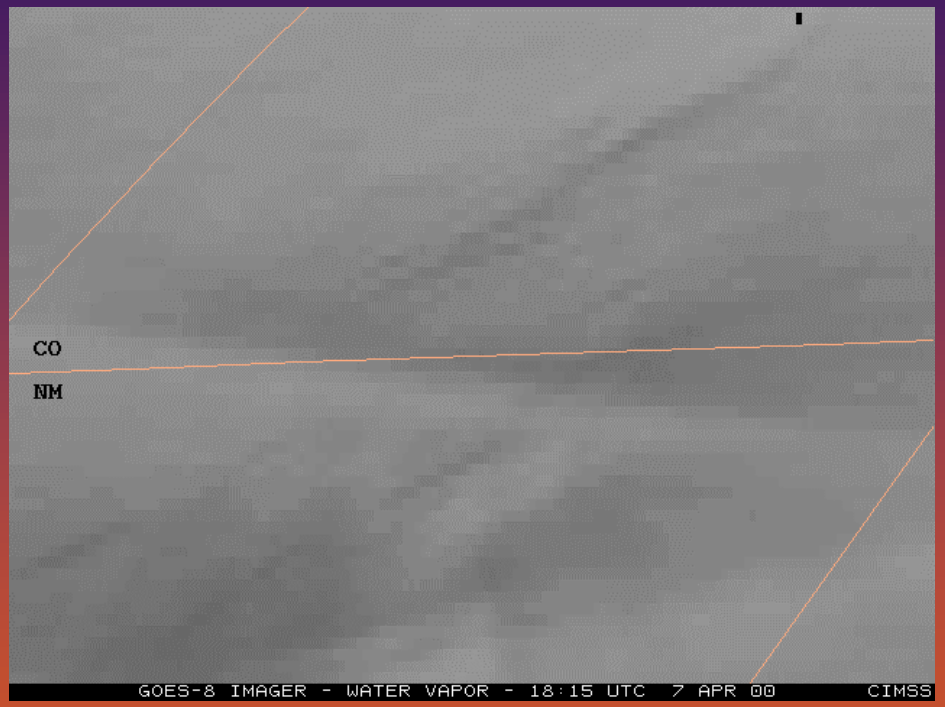
- Aircraft turbulence is caused by up and down eddies.
- Higher resolution Water Vapor channels will be able to see these eddies.
- New high resolution sounders (GIFTS) will be able to resolve some of these eddies in the vertical.

Mountain Waves in WV channel (6.7 um)
7 April 2000, 1815 UTC

Simulated ABI



Actual GOES-8



Mountain waves over Colorado and New Mexico were induced by strong northwesterly flow associated with a pair of upper-tropospheric jet streaks moving across the elevated terrain of the southern and central Rocky Mountains. The mountain waves appear more well-defined over Colorado; in fact, several aircraft reported moderate to severe turbulence over that region.

Both images are shown in GOES projection.

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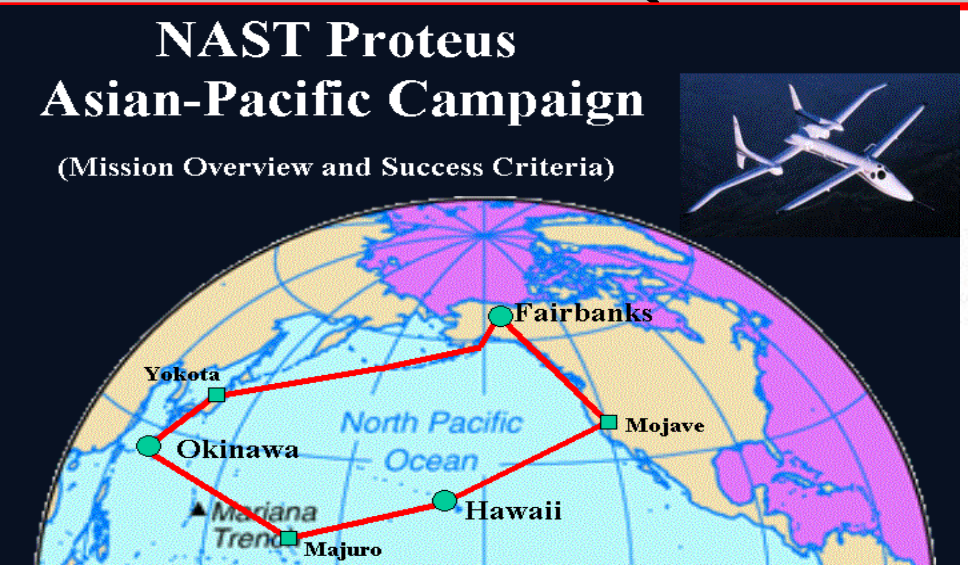
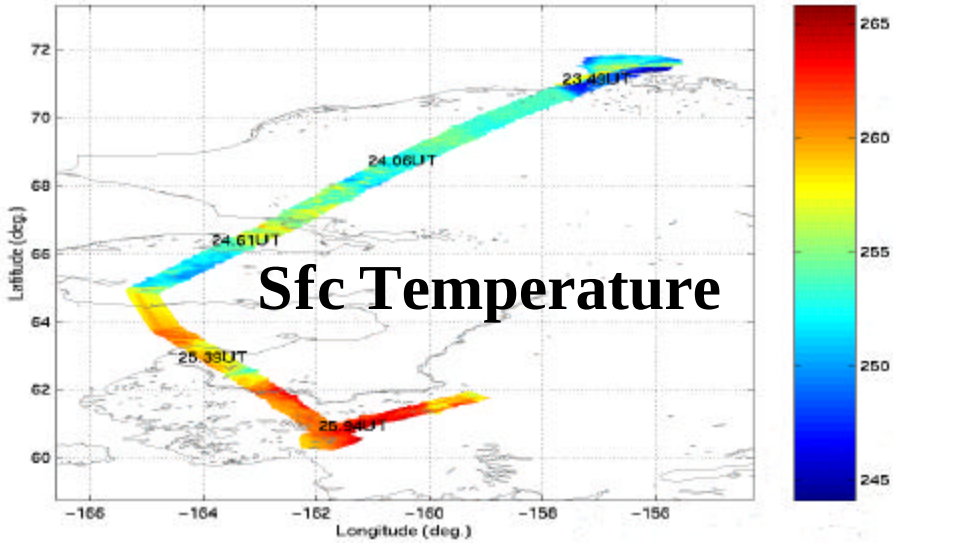
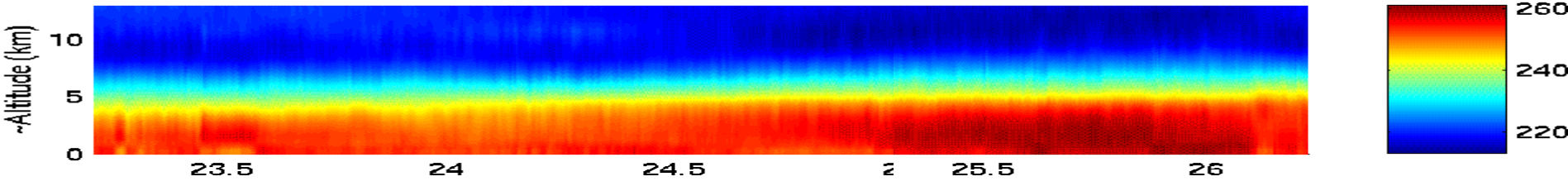
Arctic (March 20-21, 2001)

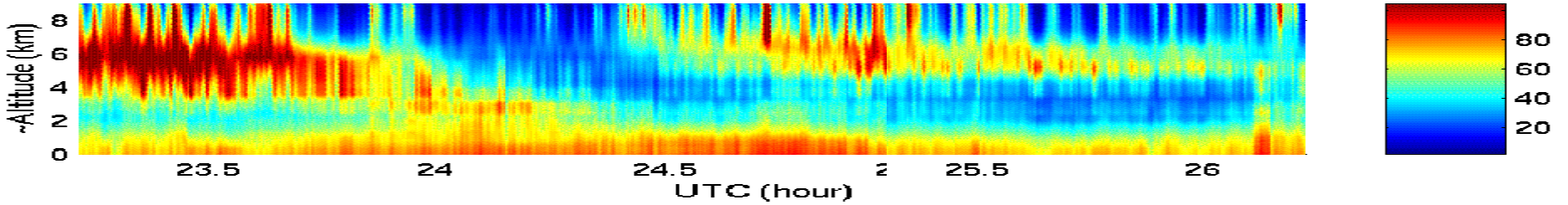




NAST-I Temperature Cross Section (K)

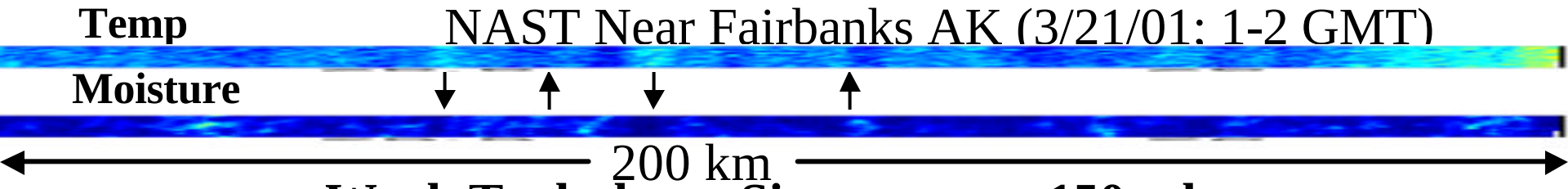


NAST-I Relative Humidity Cross Section (%)



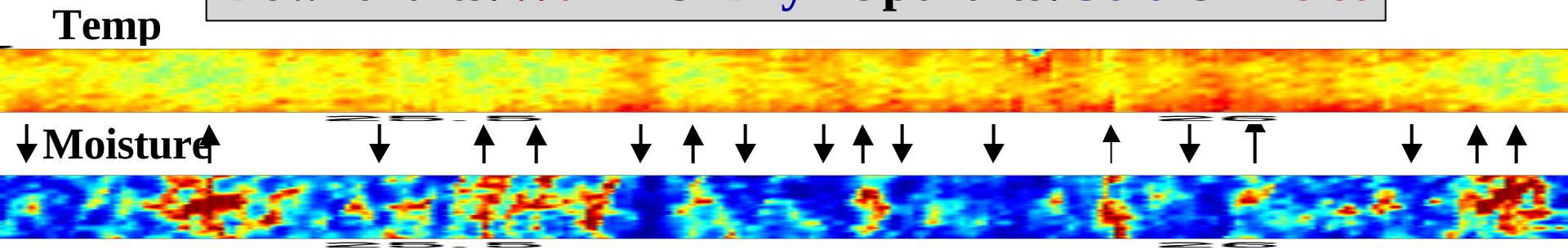
Greenwich Mean Time

Clear Turbulence?

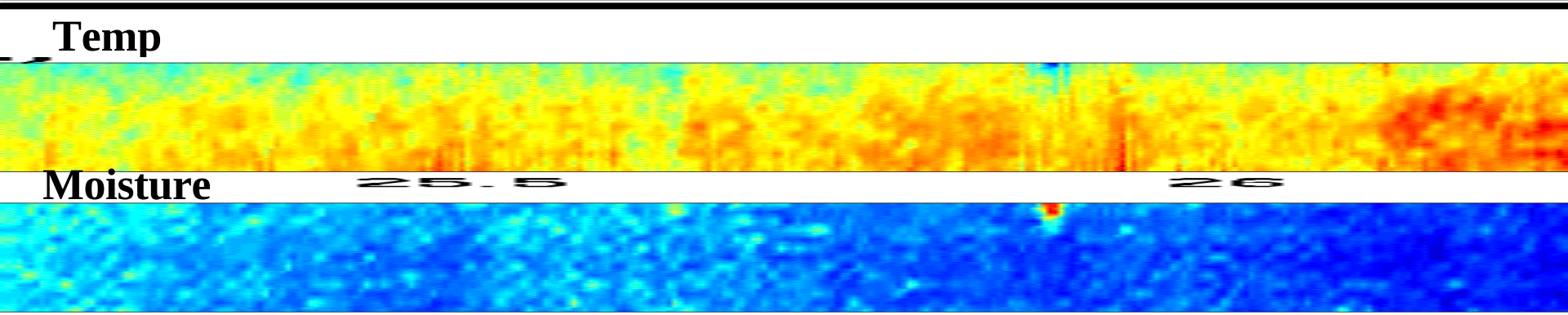


Weak Turbulence Signatures at 150 mb

Downdrafts: Warm & Dry Updrafts: Cold & Moist



Strong Turbulence Signatures at 300 mb

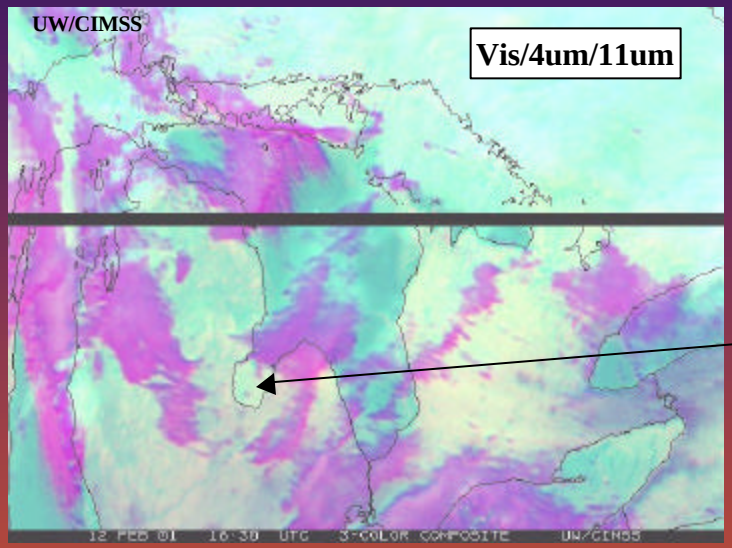


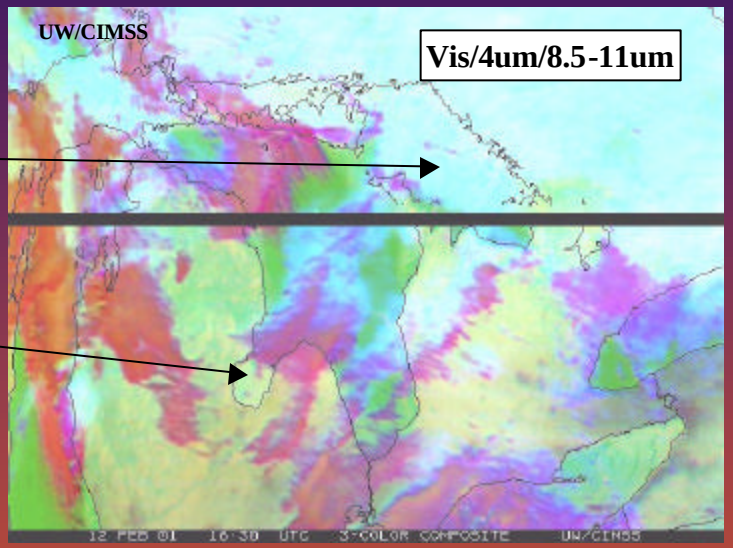
No Turbulence Signatures at 500 mb

Aircraft Icing

- Aircraft flying through super cooled liquid water droplets which stick to wings causing loss of lift and increased drag.
- Satellites will be able to detect super cooled liquid water at cloud tops.

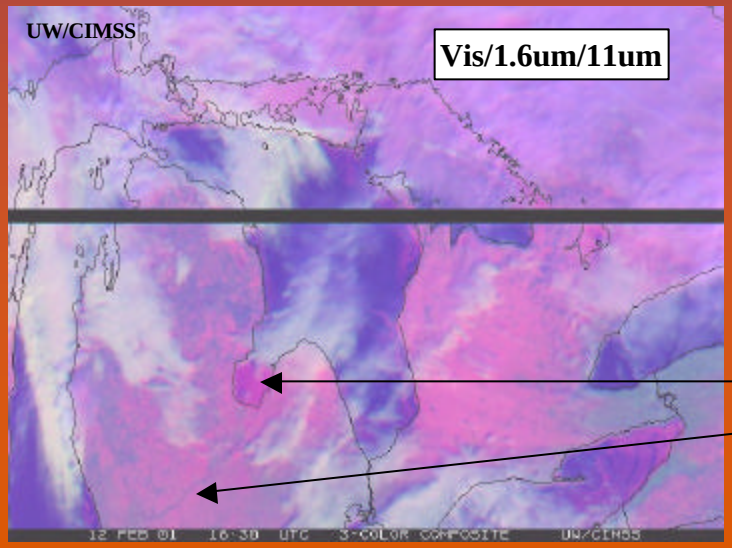
ABI Simulations: Water/Ice Clouds and Snow/Lake Ice
3-color composites February 12, 2001 16:27 UTC

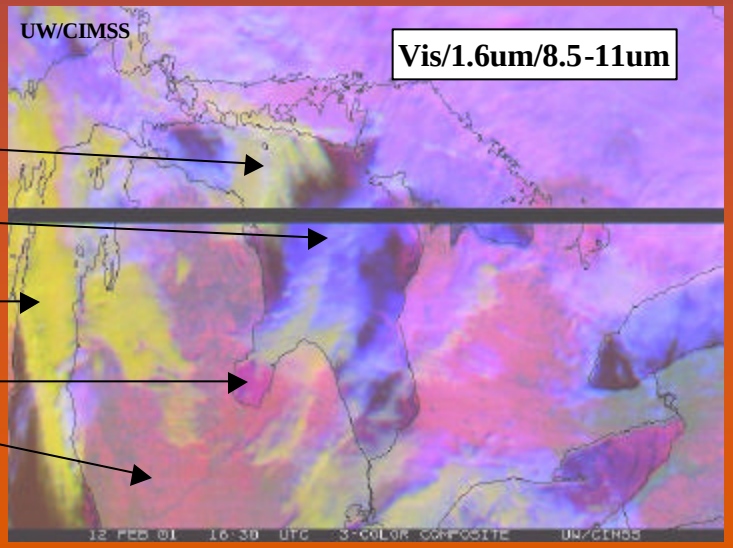




Ice cloud

Lake Ice





Water cloud

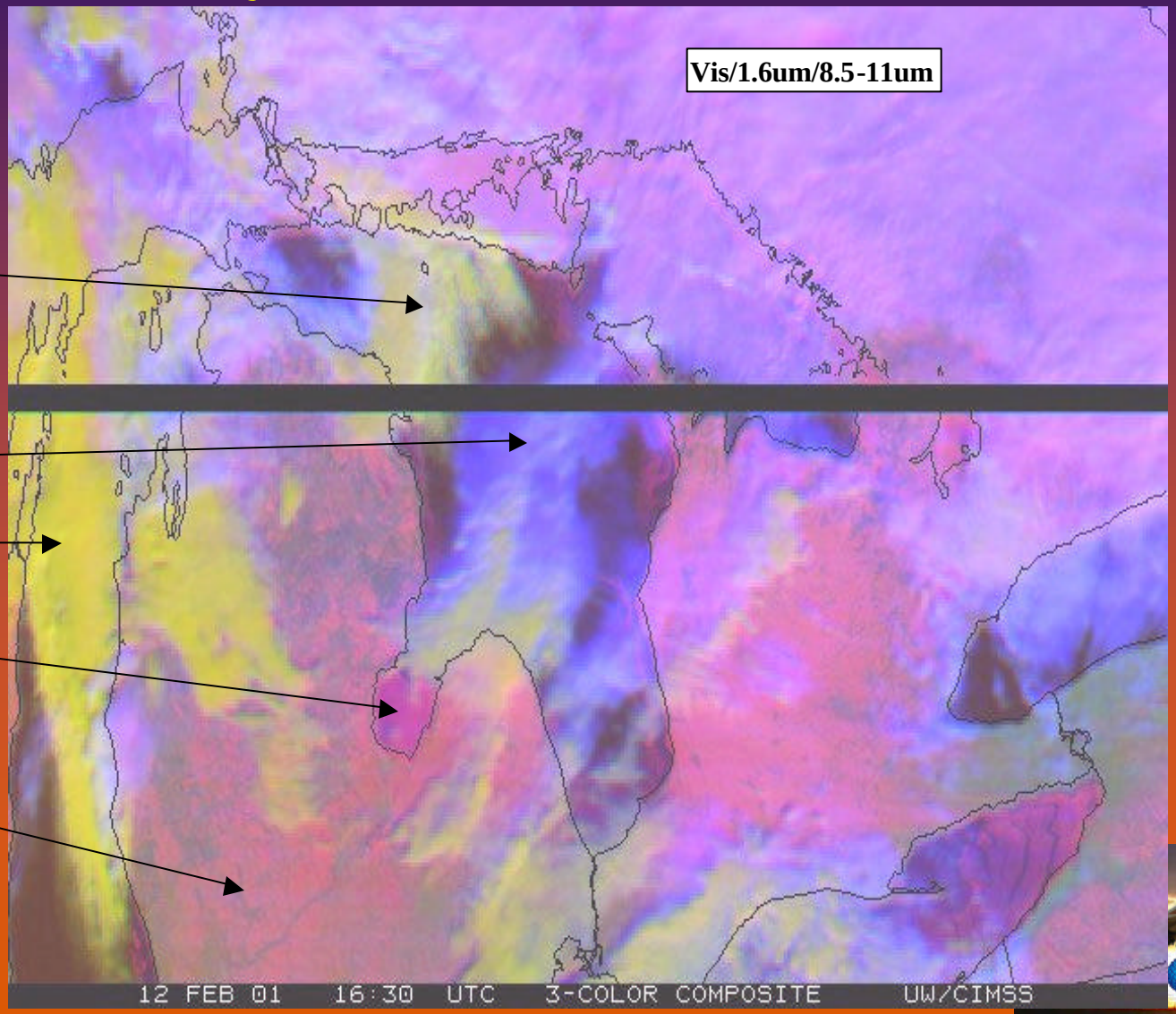
Ice cloud

Super-Cooled cloud

Lake Ice

Snow

ABI Simulations (from MODIS data)
Water/Ice Clouds and Snow/Lake Ice
3-color composite (Visible/1.6 µm/8.5-11 µm)
February 12, 2001 16:27 UTC



Water cloud

Ice Cloud

Super-Cooled cloud

Lake Ice

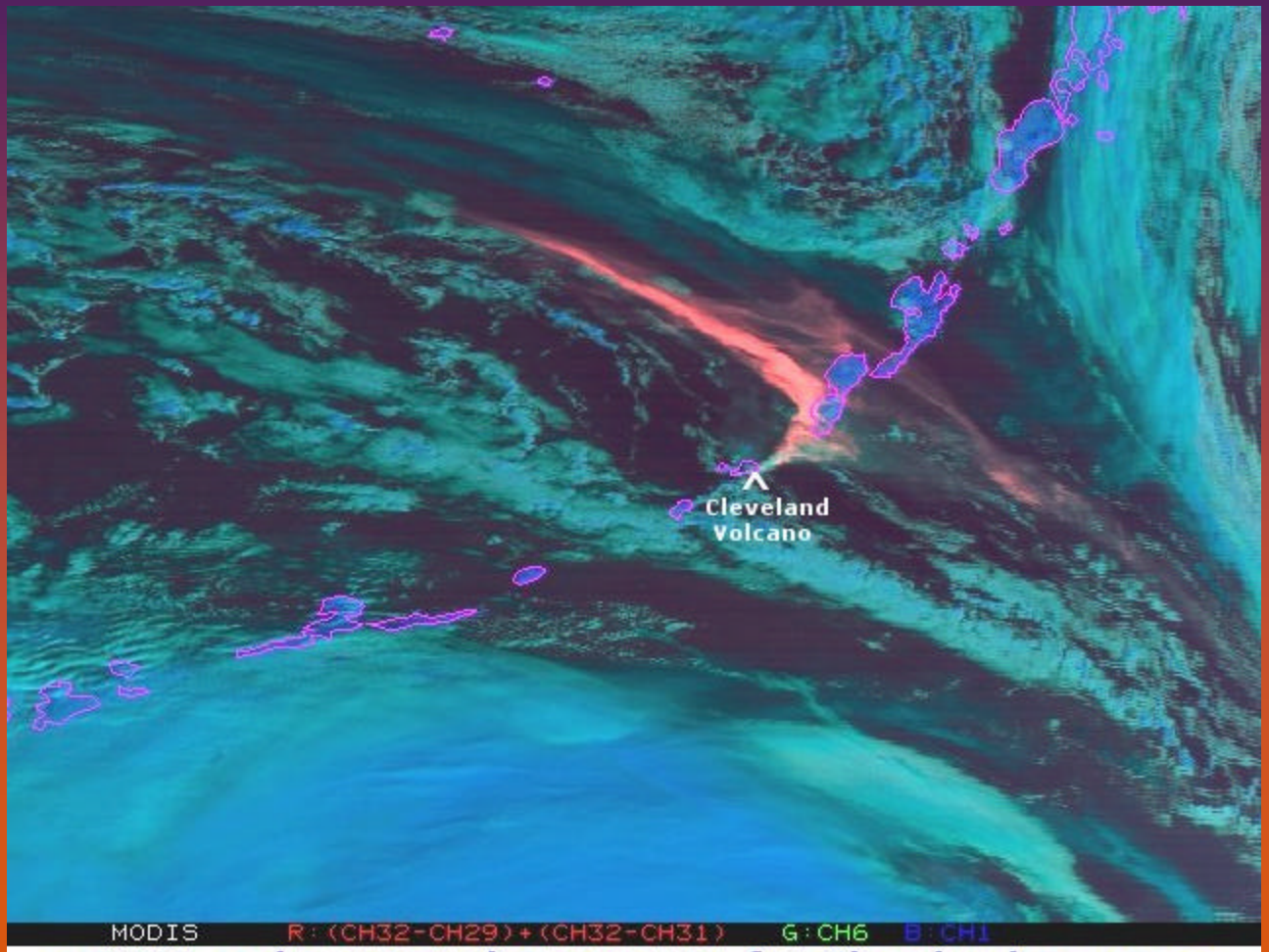
Snow

UW/CIMSS

Volcanic Ash

- Multi Channel differences can differentiate between volcanic ash and weather clouds.
- 12 micron channel detects silicates
- 3.7 micron channel detects large particle size
- 8.6 micron channel detects the SO2.

Multi-channel Volcanic Ash Detection



MODIS Multi-spectral Composite for Cleveland Eruption

RED = 8.6, 11, 12 µm composite GREEN = 1.6 µm BLUE = Visible (0.6 µm)

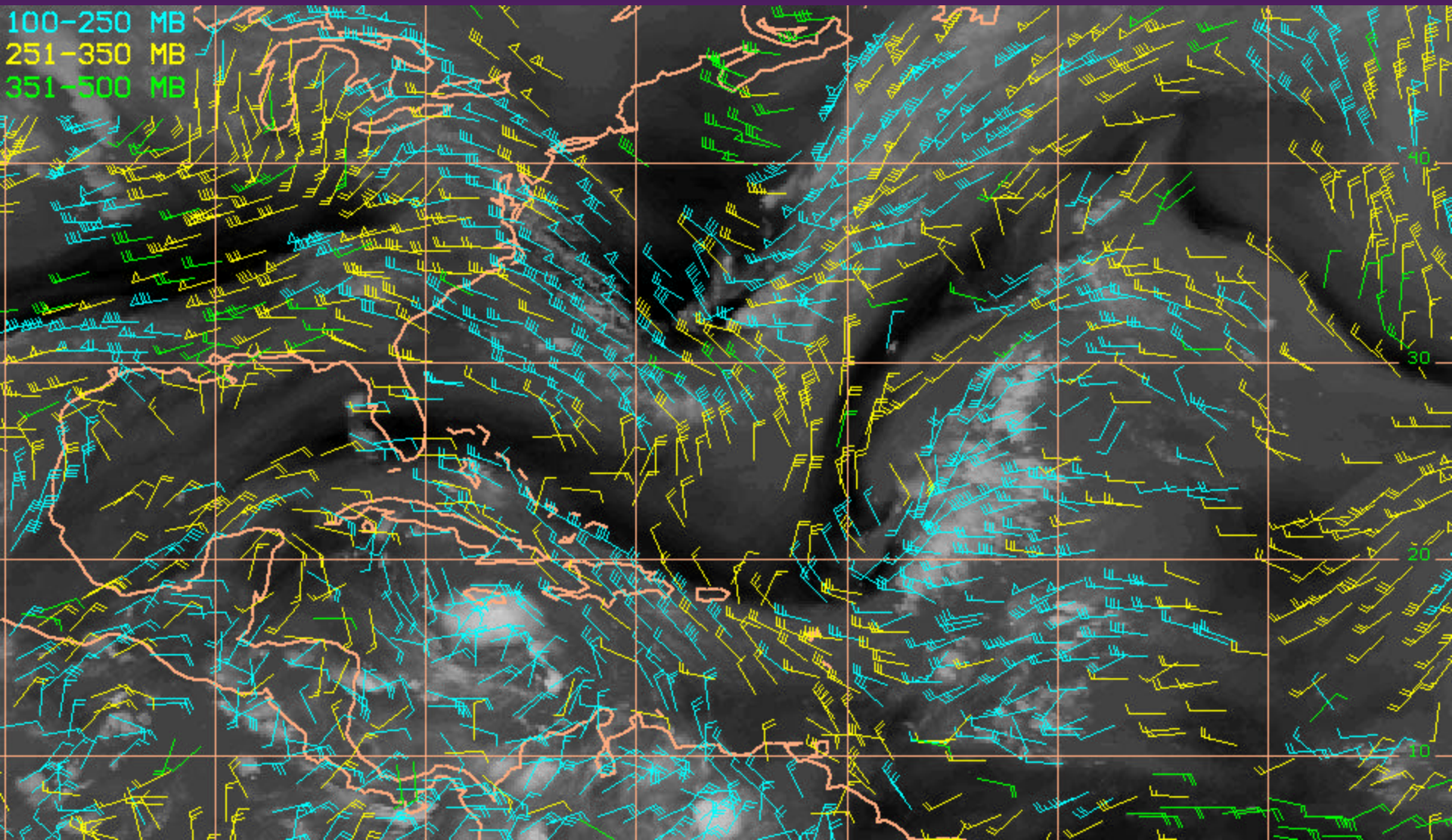
19 February 2001, 2310 UTC

J-S. Im / G. Ellrod

Winds

- Head/tail winds have a major impact on aircraft fuel consumption.
- Cloud winds measured where there are clouds.
- Water vapor winds fill in around clouds.
- Multiple water vapor channels will allow for different heights of wind measurements.

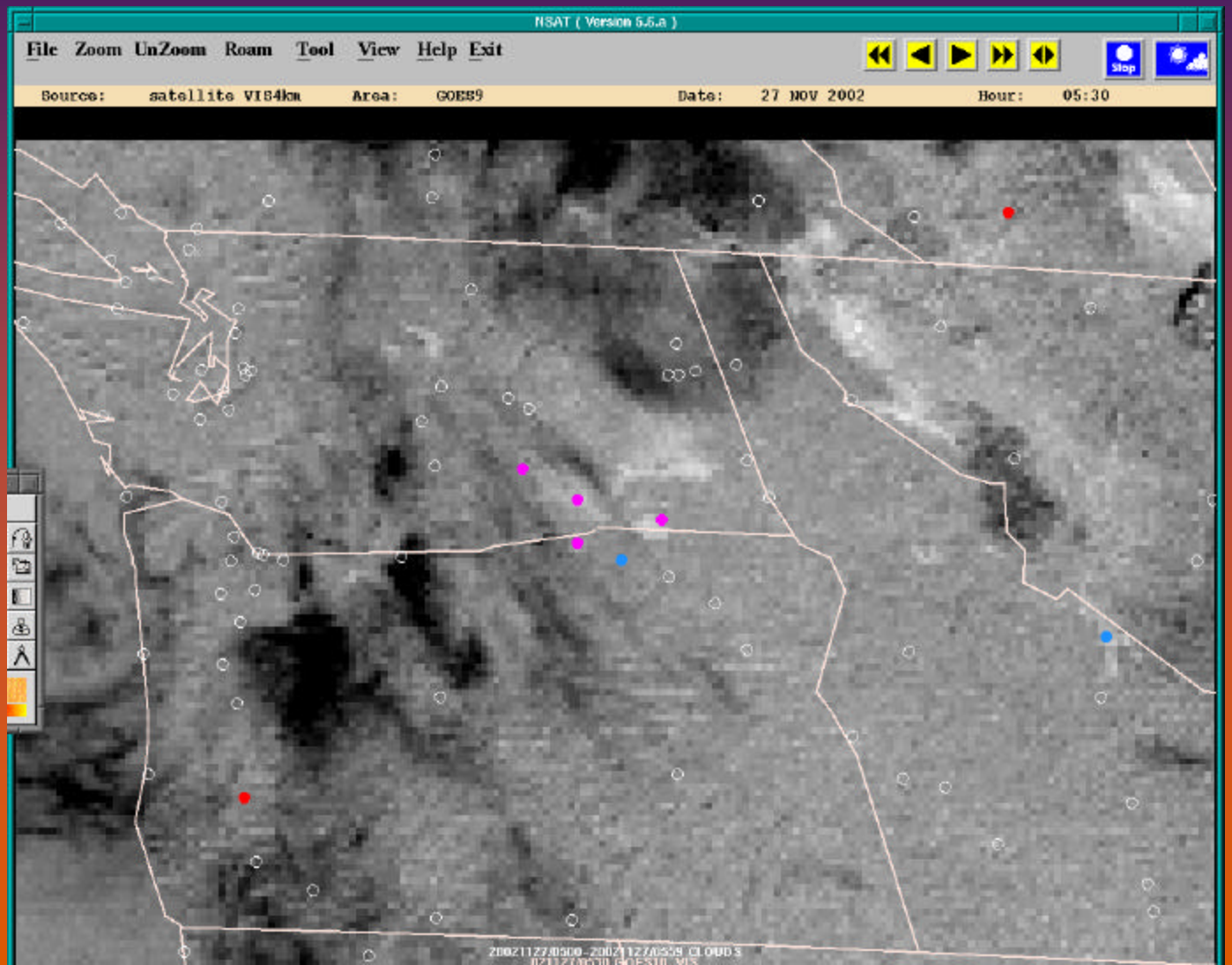
Water Vapor Winds



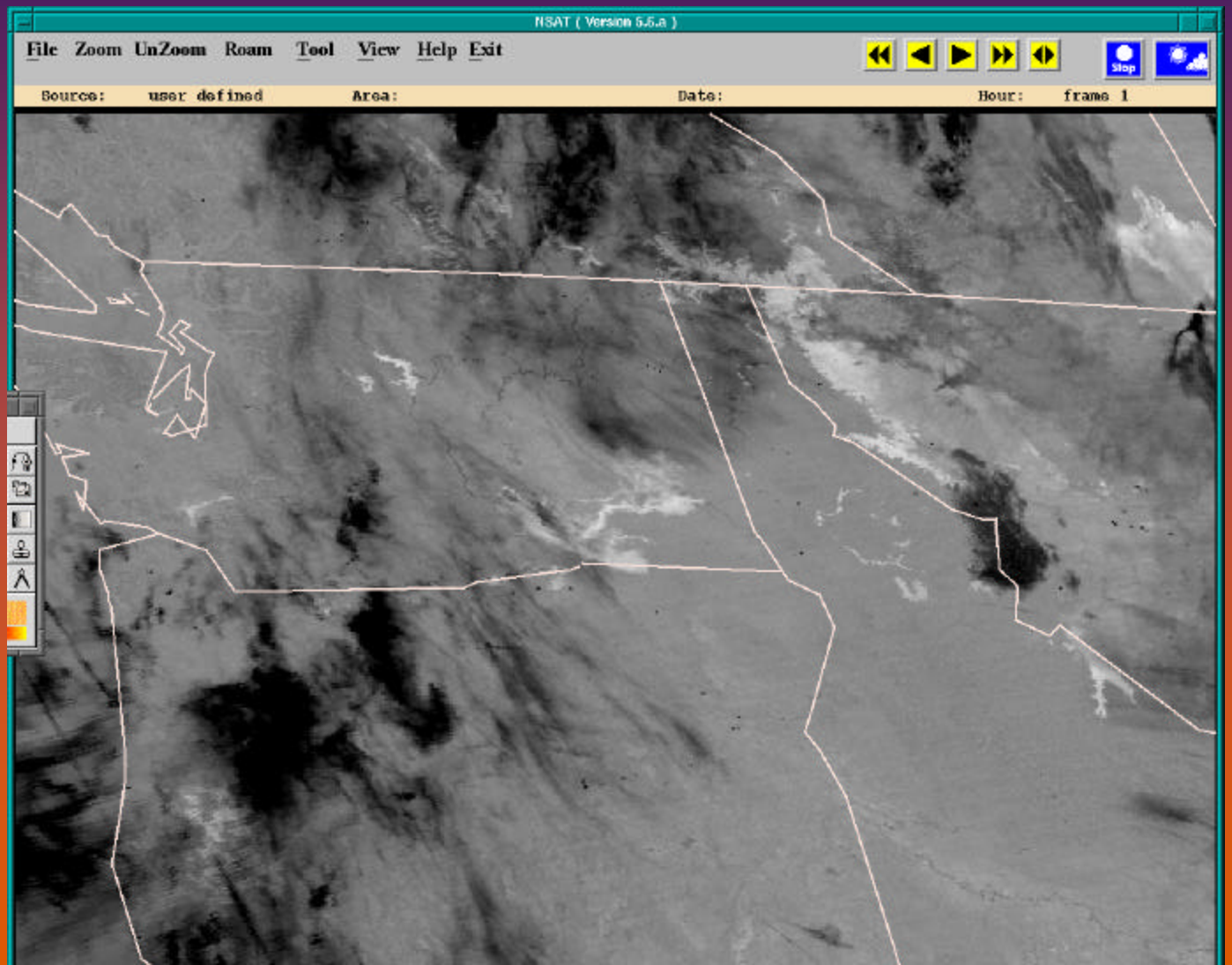
Restricted Visibility

- Two classes of pilot's license – Visible Flight Rules (VFR) and Instrument Flight Rules (IFR). Most general aviation pilots are VFR pilots. They must be able to see the ground to fly.
- Fog detection with 3.7 micron channel at night.
- Haze detection with blue and red channels.

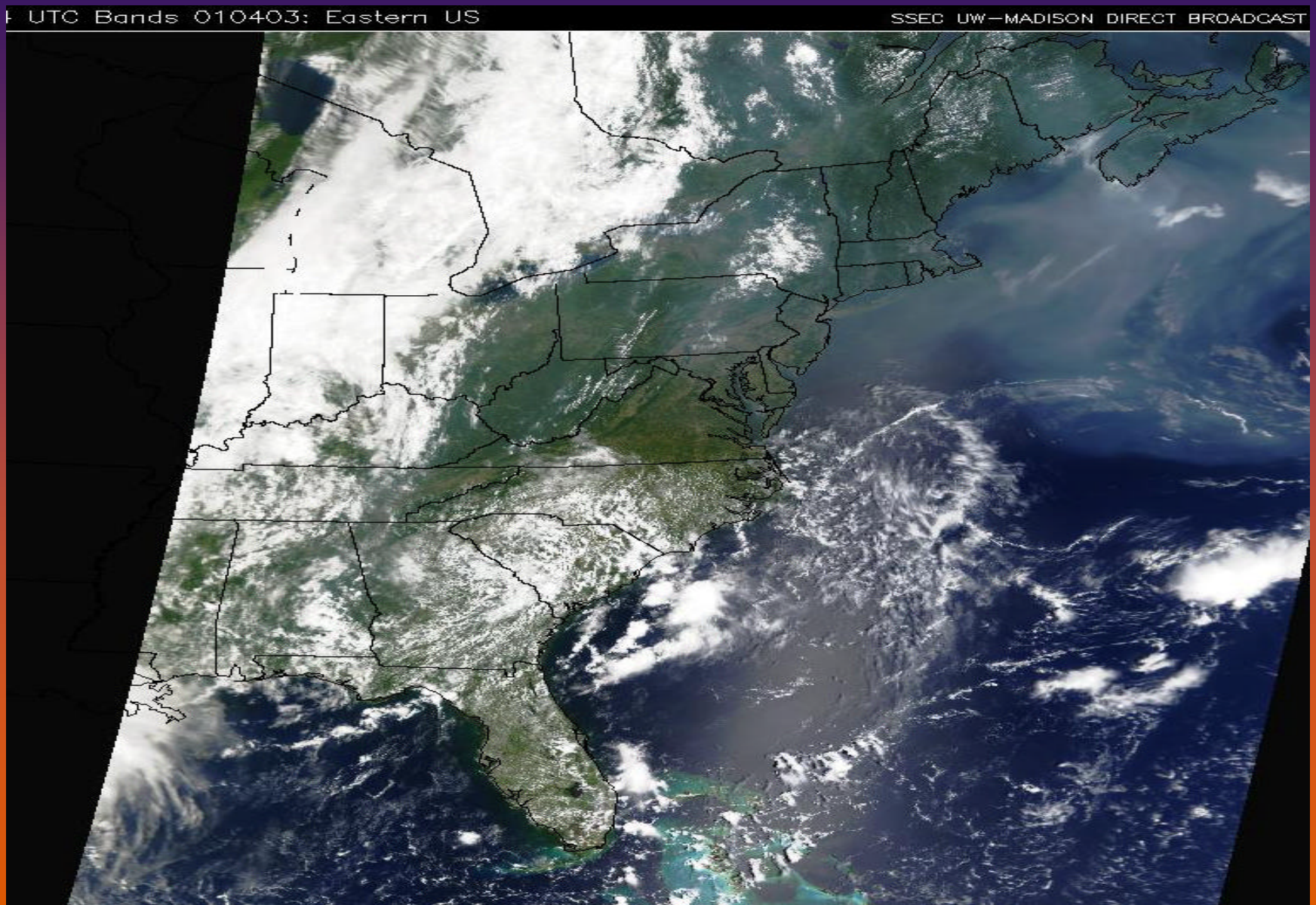
GOES-10 Fog Detection at Night



GOES-R Fog Detection at Night



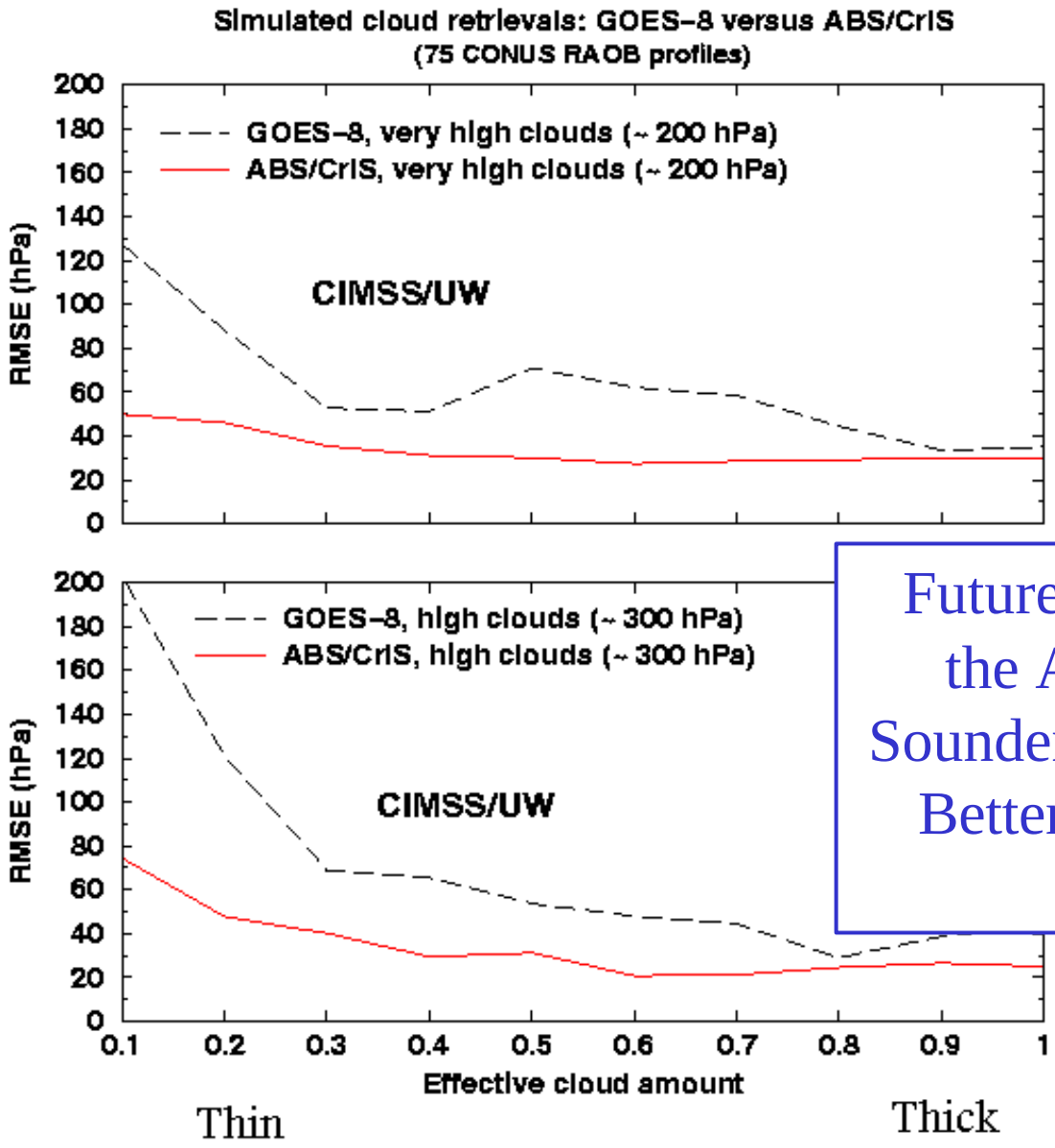
Haze Detection



Cloud Heights

- ASOS cloud heights above 12,000 feet are currently determined from GOES data.
- New GOES-R will significantly improve cloud height determination.

ABS/HES Cloud Top Pressure Retrieval Performance

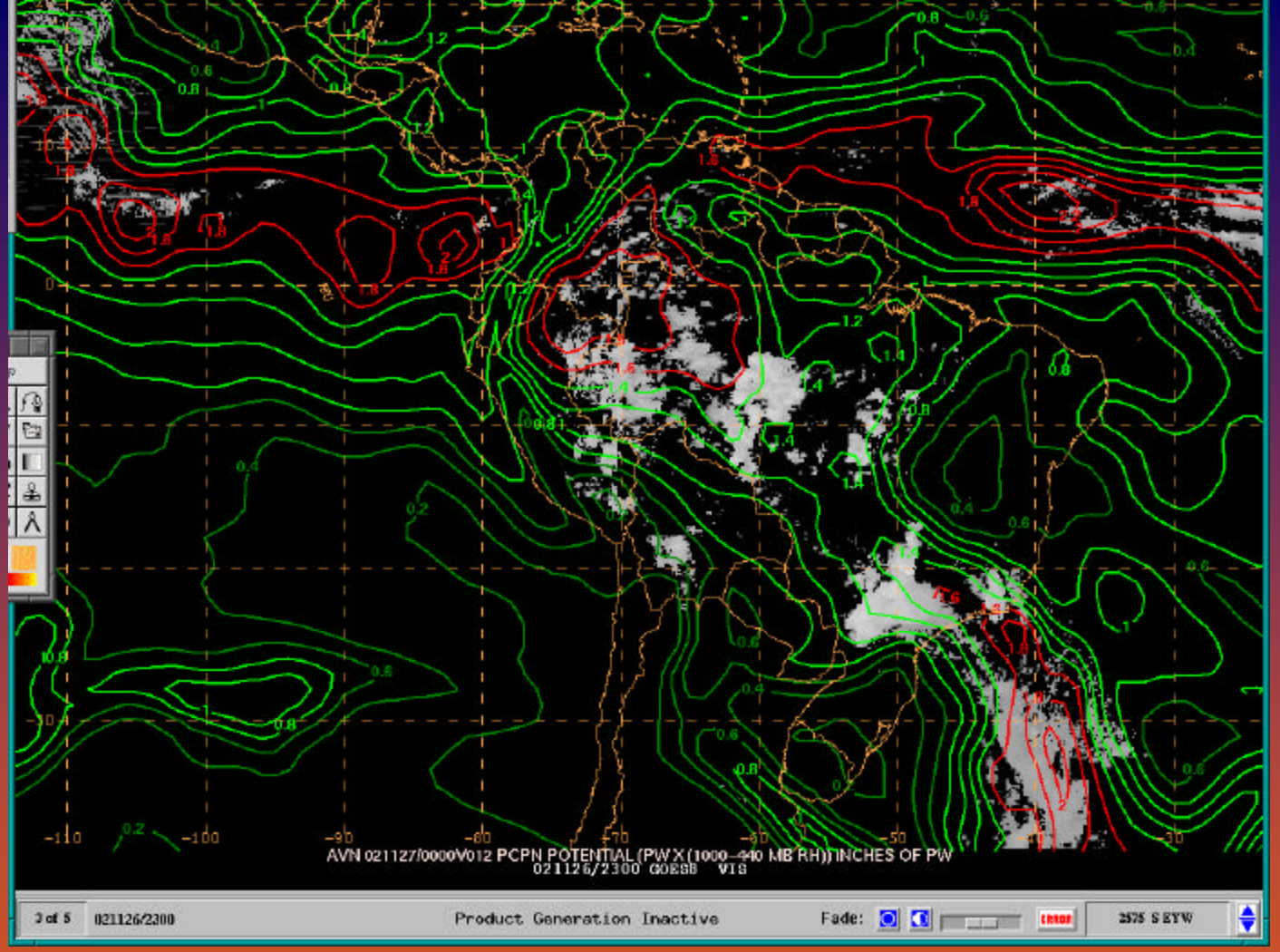


Future GOES -- simulating the Advanced Baseline Sounder (ABS) performance. Better cloud-top pressure retrievals.

(UW/CIMSS)

Numerical Models

- Higher resolution. Better physics.
- Big advances in data assimilation.
- Models are starting to effectively use satellite information.
- Assimilation techniques can utilize radiances (temperature and moisture), cloud tops, initial convection, winds, fog, etc.



GFS Precipitation Potential overlaid on Observed GCD Convection

Summary

- Satellite information is becoming more important for safe, efficient aviation operations.
- Weather forecasts are improving.
- Technologies for delivery of weather information directly to the pilots are becoming available.